Appendix D

Air Emissions Modeling and Data Output

Appendix D

Air Emission Modeling Results for the Waste Area Group 1, Test Area North Operable Unit 1-10 Group 2 Sites Remedial Action

D-1. INTRODUCTION

This appendix presents the assumptions and calculations used for, and findings from, the evaluation of emissions of radionuclides and volatile organic compounds (VOCs) that could result from the planned removal of the V-Tank wastes and affected soils in the excavation area (EA) located at Test Area North at the Idaho National Engineering and Environmental Laboratory (INEEL). The excavation area includes the area of concern immediately surrounding the V-Tanks and piping, as well as the controlled area. The purpose of this evaluation is to determine if the planned removal and soil remediation activities will produce emissions to the atmosphere that could exceed the National Emissions Standards for Hazardous Air Pollutants (NESHAP) or Idaho Administrative Procedures Act (IDAPA) requirements for toxic air pollutants. The evaluation also addresses exposure to VOCs that workers, involved in the processing of V-Tank liquids and sludges, could incur. The evaluation addresses three different emission sources: radionuclides emitted during the excavation and handling of contaminated soils, radionuclide emissions during the processing of V-Tank wastes, and VOCs released to the atmosphere during the processing of V-Tank wastes. The three emission scenarios, their general characteristics, the contaminants of concern for each, and the emission and air dispersion models used to assess their impacts are summarized in Table D-1. Each evaluation is discussed further in the following sections.

D-1.1 Radionuclides from Soils during Remediation

During the remediation of soils in the V-Tanks excavation area, radionuclides may be emitted to the atmosphere as a result of excavation and material (i.e., soil) handling and from vehicle activities. The evaluation is based on the following conservative assumptions:

1. All soils in the excavation area are contaminated at the maximum concentrations reported in Appendix H of this *Comprehensive Remedial Design/Remedial Action Work Plan for the Test Area North, Waste Area Group 1, Operable Unit 1-10, Group 2 Sites (Draft)*, October 2001 (henceforth the RD/RA WP). Those concentrations are:

   a. Co-60: 610 pCi/g

   b. Cs-137: 54,120 pCi/g

   c. Sr-90: 1,110 pCi/g.

   Sr-90 was not actually detected in the V-Tank vicinity soils. However, gross beta was detected at 1,110 pCi/g in the V-Tank vicinity soils, and Sr-90 was included in the emission and dose assessment as a proxy for the gross beta. Additionally, although not reported, Ba-137M (Note: M indicates meta stable) was included as a Cs-137 decay product at 95% of the Cs-137 concentration: 51,414 pCi/g.

2. The quantity of contaminated soil in the excavation area is assumed to be approximately 3,950 yd^3 based on engineering estimates. This is the total quantity of soil that is capable of being emitted as dust and includes 1,250 yd^3 in the immediate area of the tanks and piping, 2,200 yd^3 of soil adjacent to the area of the tanks and piping, and 500 yd^3 of fill material that will be used during the actual excavation[1]. Although highly conservative, this quantity (3,950 yd^3 or 5,919 ton [(3,950 yd^3 × 27 ft^3per yd^3 × 111 lb per ft^3)/ 2,000 lb per ton)]) will be used as a worst-case estimate for the NESHAP compliance assessment. Additionally, it is assumed that no mitigative actions such as dust suppression or enclosures are used.

3. It is assumed that soils are emitted to the atmosphere as dust. Radionuclides affixed to the dust are transported via the wind to the nearest fence line, which is approximately 12,000 m away to the northeast (NE). Release to the atmosphere occurs as a result of two mechanisms that may occur during remediation:

    a. Aggregate handling of the soils, such as from a front-end or similar loader. Aggregate handling is assumed to occur twice: first from the excavation to a stockpile, then again from the stockpile to bags. Thus, the actual quantity of soil subject to the emission estimations is 7,900 yd^3 (11,838 ton).

    b. Dust generated from vehicle tires (e.g., front-end loader) as they operate in the excavation area. For estimating emission, it is assumed that a vehicle could travel 9.5 miles overall within the excavation area during the course of the excavation.

4. Atmospheric dispersion was simulated using meteorological data for the Pocatello, Idaho, airport provided with CAP-88, assuming a 3-m release height for the loader operation and ground-level release for dust generated from vehicle tires.

5. The source area for CAP-88 was the entire area of the excavation area (390 m^2), which includes the immediate area of the tanks and piping (115 m^2) and the controlled area adjacent to the area of the tanks and piping (275 m^2).

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1. Additional information on the quantities, volumes, densities, and areas of the soils, as well as similar information for the liquids, sludges, and sand filter, is presented in the tables in Section D-3.3.3. Additionally, details of the computations and examples are provided in Section 3.

Table D-1. Summary of Air Modeling Evaluation.

Source	Description	Contaminants of Concern	Air Emission and Dispersion Models
Radionuclides from soils	During the remediation of soils in the V-Tanks EA, radionuclides may be emitted from excavation, material handling, and from vehicle activities. Maximum radionuclide concentrations will be used along with conservative assumptions to evaluate the impacts at the maximally exposed individual (MEI).	Co-60 Cs-137 Ba-137M Sr-90	Emissions computed with standard air pollution factors from AP-42 (EPA 1998). Dispersion and dose estimates computed with CAP-88 (EPA 1997).
Radionuclides from sludges and the sand filter	During removal of the V-Tank contents, radionuclides may be emitted from the handling and processing activities. Maximum radionuclide concentrations will be used along with conservative assumptions to evaluate the impacts at the MEI. The results will be very conservative since the materials removed from the V-Tanks will be sludges and liquid, the process will be within a closed system, and radionuclides are not expected to volatilize.	Co-60 Cs-137 Ba-137M Ni-60 Sr-90 Y-90	Emissions computed with standard air pollution factors from AP-42 (EPA 1998) with an engineering modification. Dispersion and dose estimates computed with CAP-88 (DOE 1997).
VOCs from the V-Tank liquids and sludges	During removal of the V-Tank contents, VOCs may be emitted from the handling and processing activities. Maximum VOC concentrations will be used along with conservative assumptions to evaluate the impacts to workers in the immediate vicinity of the tanks, and to the offsite public at the MEI location.	Trichloroethene Tetrachloroethene 1,1,1-Trichloroethane	Emissions computed with modified air pollution factors from AP-42 (EPA 1998). Dispersion and concentration estimates computed using a simple box model (Dobbins 1979) and the Chi/Q relationship developed with CAP-88 (DOE 1997).

D-1.2 Radionuclides from Sludges and the Sand Filter

The materials removed from the V-Tanks will be sludges and liquids, and the process will generally be within a closed piping system. Individual V-Tanks and containers used in the process, however, may be open to the atmosphere for short periods of time. Although the radionuclides are not volatile, it is remotely possible that radionuclides could be emitted from the handling and processing activities during removal of the V-Tank contents. Additionally, it is possible that the sludges could be released to the environment from a spill, piping rupture, or other event, resulting in a loss of containment. The evaluation of the effects for this type of event is based on the following conservative assumptions:

1. The inventory of radionuclides available for release to the atmosphere assumes that all sludges in the four tanks, and the solids or "shake" from the sand filter, are contaminated at their maximum concentrations reported in Appendix H of the RD/RA WP. Those concentrations are reported in Table D-2. It should be noted that the radionuclides in the sludge would not be easily emitted to the atmosphere. They will likely be in ionic solution with the water phase of the sludge, complexed with other solids (i.e., the sediment phase), or precipitated as part of the sediment phase. Radionuclides in the solid phase will likely be submerged owing to the higher density of the solid phase. The radionuclides listed in Table D-2 represent over 99% of the activity reported in the four tanks and the sand filter (Appendix H). Other radionuclides reported in the sludge, such as the alpha emitting actinides plutonium, uranium, americium, and europium (a beta emitter) will not be included in the emissions inventory because they constitute less than 0.2% of the total activity in the sludge and sand filter. Thus, utilizing the radionuclides and concentrations reported in Table D-2 as a basis for dispersion, modeling will significantly overestimate the CAP-88 results and any related NESHAP compliance assessment and reporting. This assertion has been confirmed through a screening-level CAP-88 simulation using maximum sludge and sand filter concentrations. The results of that simulation indicate that the dose associated with Pu-238 and Pu-239/240 is approximately 2E-9 mrem/y, which is very small (about 0.0003%) compared to the total dose of 6.5E-4 mrem/y from all sources associated with the V-Tanks and sand filter remedial action (dose assessment results are detailed in Section D-2.1).

2. The total quantity of contaminated solids (i.e., the sludge and shake from the sand filter), based on engineering estimates using quantities provided in Section 6 of the RD/RA WP was assumed to be 16,594 lb (~8.3 tons; see the Tables in Section D-3.3.3).

3. For modeling purposes, it is assumed that the solids are released to the atmosphere as dust (even though they will actually be wet) and emissions to the atmosphere are unlikely. Radionuclides affixed to the dust are transported via the wind to the nearest fence line, which is approximately 12,000 m away to the NE. Release to the atmosphere occurs as a result of resuspension, as might occur from aggregate handling similar to processing with a front-end loader. Since the sludges will actually be handled in a closed piping system and if they are released to the atmosphere (e.g., a spill), they will be wet, it is assumed that only 10% of the total inventory are actually available for release to the atmosphere. A simple and conservative engineering judgment was made to modify the emission calculation to express, in a cautious manner, the effect of the enclosed piping process and the wet characteristic of the materials. In all likelihood, there will be no emissions of radionuclides from the process piping should a spill occur; the high moisture content of the sludge will prevent emission of radionuclides on dust particles.

4. The source area for CAP-88 was 116 m^2, which is the immediate area of the tanks and piping (i.e., 115 m^2) rounded up.

5. Atmospheric dispersion was simulated using meteorological data for the Pocatello, Idaho, airport provided with CAP-88 assuming ground-level release.

D-1.3 VOCs from V-Tank Liquids and Sludges

The materials removed from the V-Tanks will be sludges and liquids. The process will take place within a closed system. Some of the chemicals reported in the tank liquids are volatile and, during removal of the V-Tank contents, it is possible that the VOCs may be emitted from the handling and processing activities. Additionally, it is possible that the VOCs could be released to the atmosphere from a spill, piping rupture, or other event resulting in a loss of containment. The evaluation of the effects for this type of event is based on the following conservative assumptions:

1. The inventory of VOCs available for release to the atmosphere assumes that all liquids in the four tanks are contaminated at the maximum concentrations reported in Appendix H of the RD/RA WP. Those concentrations are reported in Table D-3.

2. Based on estimates from Section 6 of the RD/RA WP, the estimated total quantity of sludges and liquids is 11,899 gallons.

3. For modeling purposes, the VOCs are assumed to be released to the atmosphere as volatile compounds based on their comparatively high vapor pressures. Release to the atmosphere is assumed to occur as a result of evaporation as might result from cleaning tank cars or drums. Based on AP-42 (EPA 1998), evaporative losses of pure tetrachloroethene from cleaning tank cars can approximate ~ 0.22% of the total. The three principal VOCs (trichloroethene, tetrachloroethene, and 1,1,1-trichloroethane), when summed, represent a maximum concentration of approximately 6.0%. Thus, a simple and conservative fraction of 0.00013 (0.0022 * 0.06) of the total inventory (liquids and sludges) was assumed for the three VOCs.

Table D-2. Radionuclide Concentrations Assumed for the Sludge and Sand Filter Inventory.

Radionuclide	Tank V-1 (pCi/g)	Tank V-2 (pCi/g)	Tank V-3 (pCi/g)	Tank V-9 (pCi/g)	Sand Filter (pCi/g)
Co-60	446,000	705,000	321, 000	1,160,000	36,200
Cs-137	15,800,000	14,100,000	13,200,000	6,370,000	109,000
Ba-137M [a]	15,010,000	13,395,000	12,540,000	6,051,500	103,550
Ni-63	3,310,000	1,750,000	1,770,000	NR[b]	NR[b]
Sr-90	14,300,000	16,500,000	44,500,000	7,070,000	103,000
Y-90 [c]	14,300,000	16,500,000	44,500,000	7,070,000	103,000

Notes:

1. Co-60, Cs-137, Ba-137M, Ni-63, Sr-90, and Y-90 represent over 99% of the activity in these sludges and solids.

2. Daughter product ratios were computed using *RadDecay* (Grove Engineers 1995)

a. Ba-137M is the short-lived meta stable daughter of Cs-137. It is assumed to be ~ 95% of the Cs-137 concentration.

b. NR = not reported

c. Y-90 is the daughter of Sr-90. It is assumed to be ~ 100% of the Sr-90 concentration.

Table D-3. VOC Concentrations Assumed for Inventory.

Liquids				
VOC	Tank V-1 µg/L	Tank V-2 µg/L	Tank V-3 µg/L	Tank V-9 µg/L
Trichloroethene	160	300	200	410,000
Tetrachloroethene	140	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	58,000
Solids (Sludges)				
VOC	Tank V-1 mg/kg	Tank V-2 mg/kg	Tank V-3 mg/kg	Tank V-9 mg/kg
Trichloroethene	23	5.9	36	22,000
Tetrachloroethene	1,800	541	480	600
1,1,1-Trichloroethane	ND	ND	ND	2,600

1. These three chemicals (trichloroethene, tetrachloroethene, and 1, 1, 1-trichloroethane) represent over 99% of the VOC mass in the V-Tank sludges.

2. ND = Not Detected

Once emitted, the VOCs are transported via the wind to the nearest fence line, which is approximately 12,000 m away to the NE. Additionally, VOC exposure point concentrations are estimated to evaluate worker exposures in the near vicinity of the V-Tanks and processing equipment.

4. Atmospheric dispersion was simulated using the Chi/Q (Chi over Q) relationships developed for the ground level release of radionuclides from the sludges and sand filter discussed in Section D-1.2 using CAP-88. This approach utilizes meteorological data for the Pocatello, Idaho, airport to disperse the VOCs to the maximally exposed individual using the same algorithms as used before. The Chi/Q value used in these calculations, 6.2E-8 sec/m^3, is for the NE vector at a distance of 12,000 meters.

Worker exposure point concentrations were estimated using a simple and conservative box model. Conceptually, the box model functions as a tent or "box" over the V-Tanks so that vapor concentrations can be computed and compared with Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs).

D-2. RESULTS

The results for each evaluation are presented in this section.

D-2.1 Results of Radionuclide Emission Modeling

The results for the radionuclide emission modeling are presented in Table D-4. To facilitate regulatory analysis, the table also presents the NESHAP regulatory requirement for radionuclides, which is 10 mrem/y from all INEEL sources. Inspection of the table indicates that both sources of radionuclide emissions combine to produce an effective dose equivalent (i.e., dose) of 6.5 E-4 mrem/y (see Table D-4), which is more than fifteen thousand times below the NESHAP requirements of 10 mrem/y. Readers should note that the NESHAP requirements are intended to govern all INEEL sources combined. Thus, air emissions from the removal, treatment, and disposal of the V-Tank wastes are expected to contribute a very small amount to the overall INEEL allocated dose limit. It is important to bear in mind the conservatism embodied in these dose estimates, particularly the radionuclides from sludges and the sand filter component, as well as the conservative volume of soils assumed for the soil emission estimations. It is probable that the doses presented in Table D-4 overstate the actual doses by a factor of ten or more. In all likelihood, removal, treatment, and disposal of the V-Tank wastes will not produce any discernable dose to an offsite receptor.

Table D-4. Results of Radionuclide Emission Modeling.

Emission Source	Estimated MEI Dose [a] (Located at the NE Fence Line)	NESHAP Requirement [b] (All INEEL Sources)
Radionuclides from soils	6.5E-4 mrem/y	**10 mrem/y**
Radionuclides from sludges and the sand filter	8.3E-8 mrem/y	
Total	**6.5E-4 mrem/y**	

a. This is the effective dose equivalent (EDE).

b. 40 CFR Part 61 limits the INEEL to 10 mrem/y from all sources.

D-2.2 Results of VOC Emission Modeling

The results for the VOC emission modeling to the fence line are presented in Table D-5. The table also presents the IDAPA regulatory requirement for each VOC.

Table D-5. Results of VOC Emission Modeling to the Fence Line

VOC	Estimated Fence Line Concentration	IDAPA Requirement
Trichloroethene	9.9E-11mg/m^3	7.7E-4 mg/m^3 [a]
Tetrachloroethene	3.0E-11mg/m^3	2.1E-3 mg/m^3 [a]
1,1,1-Trichloroethane	1.3E-13 mg/m^3	95.5 mg/m^3 [b]

a. These are IDAPA average annual acceptable ambient concentrations for carcinogens (AACCs) (IDAPA 2001).

b. This is the IDAPA acceptable ambient concentration (AAC) for the non-carcinogenic 1,1,1- trichloroethane, also known as methyl chloroform (CAS No. 71-55-6) (IDAPA 2001).

Inspection of the table indicates that concentrations of both trichloroethene and tetrachloroethene, estimated at the nearest fence line, are far below their respective IDAPA regulatory requirements. Moreover, IDAPA's requirements for these compounds are ambient air average annual (365-day) concentrations, and the V-Tank waste processing is expected to last approximately 60 days. In essence, the estimated concentrations in Table D-5 are 60-day averages. Consequently, for trichloroethene and tetrachloroethene there is an additional safety factor of 6 (60/365) in the Table D-5 comparisons.

The IDAPA acceptable ambient concentration for 1,1,1-trichloroethane is 95.5 mg/m^3. As indicated, the estimated fence line concentration of 1.3 x 10^{-13} mg/m^3 is many orders of magnitude below the regulatory requirement. The results and comparisons obtained from Table D-5 further indicate that processing the V-Tank wastes can be accomplished without challenging IDAPA's requirements for toxic air pollutants.

The results for the VOC emission estimation and worker exposure modeling are presented in Table D-6. The table also presents the IDAPA emission rate screening limit requirements for each VOC emission, as well as the applicable OSHA PEL.

Table D-6. Results of VOC Emission Estimations and Worker Exposure Modeling.

VOC	Emission Rate (lb/hr)	IDAPA Requirement[a] (lb/hr)	Worker Exposure Concentration (mg/m^3)	OSHA PEL[b] (mg/m^3)
Trichloroethene	1.3E-5	5.1E-4	2.6E-5	5.4E+2
Tetrachloroethene	3.8E-6	1.3E-2	7.9E-6	6.8E+2
1,1,1-Trichloroethane	1.7E-9	1.3E+2	2.6E-8	1.9E+3

a IDAPA Screening Emission Limits (EL) from Sections 58.01.01,585 and 586 (2001)

b 29 CFR 1910.1000, Table Z-2 (OSHA 1997)

Inspection of Table D-6 illustrates that the conservatively estimated VOC emission rates are expected to be well below IDAPA screening emission limits. The VOC emission calculations were based on EPA's methods for cleaning rail cars and tank trucks using cleaning agents, such as water, steam, and detergents that are applied using steam hoses, pressure wands, rotating spray nozzles, and the like (EPA 1998). It is possible that compressed air may be used for processing the V-Tank materials. Although EPA does not explicitly mention compressed air in their AP 42 study (EPA 1998), it is considered reasonable that, given the examples cited, the estimation method is suitable for estimating emissions that could result from the use of compressed air as well.

In addition, worker exposure concentrations in the vicinity of the V-Tanks should not approach OSHA compliance limits.

D-3. EMISSION ESTIMATION COMPUTATIONS

The emission calculations used to develop the fence line and worker exposure estimates in the previous section are presented in the following sections.

D-3.1 Emissions of Radionuclides from Soils during Remediation

Emissions resulting from excavation, material handling, and vehicle activities during the remediation of soils in the V-Tanks excavation area are computed with two equations taken from AP-42, Section 13 (EPA 1998). They are given below:

$$E(\text{lb/ton}) = k(0.0032)\frac{\left[\frac{U}{5}\right]^{1.3}}{\left[\frac{M}{2}\right]^{1.4}} \tag{D-1}$$

$$E(\text{lb/VMT}) = \frac{k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{b}}{\left(\frac{M}{0.2}\right)^{c}} \tag{D-2}$$

Equation (D-1) estimates the pounds of dust emitted per ton of soil handled, and Equation (D-2) estimates the pounds of dust emitted per vehicle mile traveled (VMT). As discussed previously, maximum radionuclide soil concentrations were used to derive a conservative estimate of emission arising from soil remediation in the excavation area. Details and the parameters used in these equations are presented in Tables D-7 and D-8, respectively. The radionuclide emissions in pCi/year that were entered into CAP-88 can be found in **bold** text on the far right side of Table D-9 as the sum from both operations in the column headed **Ci**.

D-3.2 Radionuclides from Sludges and the Sand Filter

During removal of the V-Tank contents, radionuclides may be emitted from the handling and processing activities. Emissions are estimated using the same equation used for the excavation and material handling activities during the remediation of soils in the V-Tanks excavation area (Equation [D-1]) with an engineering modification to account for the facts that:

- The solids will actually be handled in a closed piping system and they are not likely to be released to any extent.
- The materials will be wet and they are not likely to be released to any degree.

The equation, modified from AP-42 (EPA 1998), is as follows:

$$E(\text{lb/ton}) = k(0.0032)\frac{\left[\frac{U}{5}\right]^{1.3}}{\left[\frac{M}{2}\right]^{1.4}} \times \text{EFactor} \tag{D-3}$$

Table D-7. Emission Rates of Varying Particulate Matter Sizes.

Pickup and dropping emissions from excavation (lb/Ton)	PM-30	PM-15	PM-10	PM-5	PM-2.5	Sums, pCi	Sum Ci
E = emission factor (lb emitted/Ton handled)	0.00097	0.0006	0.00046	0.00026	0.00014	0.002	
Multiplier for handling twice	2.0	2.0	2.0	2.0	2.0	2.0	
lbs soil emitted (@ 5919 tons handled twice)	11.455	7.430	5.418	3.096	1.703	29.102	
grams soil emitted (@ 5919 tons handled twice)	5,201	3,373	2,460	1,406	773	13,212	
Co-60 emitted (pCi), (Csoil max = 610 pCi/g)	3,172,331	2,057,728	1,500,427	857,387	471,563	8,059,435	**8.1E-06**
Cs-137 emitted (pCi), (Csoil max = 54,120 pCi/g)	281,453,351	182,564,336	133,119,828	76,068,473	41,837,660	715,043,648	**7.2E-04**
Ba-137 emitted (pCi), (95% of Cs-137)	267,380,683	173,436,119	126,463,837	72,265,049	39,745,777	679,291,465	**6.8E-04**
Sr-90 emitted (pCi), (Csoil max = 1,110 pCi/g proxy value of gross beta)	5,772,602	3,744,390	2,730,285	1,560,163	858,089	14,665,529	**1.5E-05**
k = particle size multiplier (EPA 1998)	0.74	0.48	0.35	0.2	0.11		
U =mean wind speed (mph) (DOE 2000b)	8.2						
M = moisture content (%) (DOE 2000b)	6						
Constant	0.0032						
Equilibrium fraction of Ba-137M to Cs-137 =	0.95						

See example estimate of *E* for PM-30 below
See Equation D-1

Equation from EPA (1998)

See example estimate of Co-60 in the PM-30 range below
Note small rounding discrepancies
Table D-13 summarizes volumes and quantities of soils

$$E(0.00097\,\mathrm{lb/ton}) = 0.74(0.0032)\frac{\left[\dfrac{8.2}{5}\right]^{1.3}}{\left[\dfrac{6}{2}\right]^{1.4}}$$

Example estimate of E for PM30 (See Table D-7 for comparison)

$$3{,}180{,}063\ \mathrm{pCi} = \frac{0.00097\ \mathrm{lb}}{\mathrm{ton}} \times 2\ \mathrm{handlings} \times 5{,}919\ \mathrm{tons} \times \frac{454\ \mathrm{g}}{\mathrm{lb}} \times \frac{610\ \mathrm{pCi}}{\mathrm{g}}$$

Example estimate of CO-60 for PM30 (See Table D-7 for comparison)

Note small rounding discrepancy

Table D-8. Vehicle Emissions from Excavation (Dust from Vehicle Wheels).

Emissions from vehicle traffic within the AOC	PM-30	PM-15 [1]	PM-10	PM-5 [1]	PM-2.5	Sums	Sum Ci
E = emission factor (lb/VMT)	2.96	1.32	0.90	0.39	0.13	5.70	
lbs of soil emitted (@ 9.5 VMT)	28.2	12.6	8.6	3.7	1.3	54.4	
grams of soil emitted (@ 9.5 VMT))	12,813	5,702	3,916	1,687	572	24,691	
Co-60 emitted (pCi), (Csoil max = 610 pCi/g)	7,816,118	3478172.5	2389048.1	1029128.4	349168.6	15,061,636	**1.5E-05**
Cs-137 emitted (pCi), (Csoil max = 54,120 pCi/g)	693,456,247	308,588,030	211,959,478	91,305,621	30,978,693	1,336,288,069	**1.3E-03**
Ba-137 emitted (pCi), (95% of Cs-137)	658,783,434	293,158,628	201,361,504	86,740,340	29,429,758	1,269,473,665	**1.3E-03**
Sr-90 emitted (pCi), (Csoil max = 1,110 pCi/g proxy value of gross beta)	14,222,772	6,329,134	4,347,284	1,872,676	635,372	27,407,239	**2.7E-05**
k = particle multiplier (dimensionless)	10	4.5	2.6	1.1	0.38		
a	0.8	0.8	0.8	0.8	0.8		
b	0.5	0.5	0.4	0.4	0.4		
c	0.4	0.4	0.3	0.3	0.3		
VMT (excavation hours x mph)	9.5						
s = silt content % (from DOE 1998)	4.7						
S = mean vehicle speed (mph) (DOE 2000b)	0.1						
W = mean vehicle weight (tons) (DOE, 2000b)	17.85						
M = moisture content (%) (DOE 2000b)	6						
Tonnage to be excavated	5919						
Excavation rate, ton/hr (typical excavation, DOE 2000b)	62						
Excavation hours (tonnage / excavation rate)	95						

Example estimate of *E* for PM-30 below
See Equation D-2
Equation from EPA (1998)

Example estimate of Co-60 in the PM-30 range below

[1] PM-15 and PM-5 based on linear interpolation from PM-30 and PM-10, and PM-10 and PM-2.5, respectively
Table D-13 summarizes volumes and quantities of soils

$$E(2.96\,\mathrm{lb/VMT}) = \frac{10 \times \left(\frac{4.7}{12}\right)^{0.8} \times \left(\frac{17.85}{3}\right)^{0.5}}{\left(\frac{6}{0.2}\right)^{0.4}}$$

Example estimate of E for PM30 (See Table D-8 for comparison)

$$7{,}787{,}553\,\mathrm{pCi} = \frac{2.96\,\mathrm{lb}}{\mathrm{VMT}} \times 9.5\,\mathrm{VMT} \times \frac{454\,\mathrm{g}}{\mathrm{lb}} \times \frac{610\,\mathrm{pCi}}{\mathrm{g}}$$

Example estimate of CO-60 for PM30 (See Table D-8 for comparison)

Note small rounding discrepancy

Table D-9. Emission from Both Operations

Sum both operations	PM-30	PM-15	PM-10	PM-5	PM-2.5	pCi	Ci [a]
Co-60 emitted (pCi), (Csoil max = 610 pCi/g)	10,988,449	5,535,901	3,889,475	1,886,515	820,731	23,121,071	**2.3E-05**
Cs-137 emitted (pCi), (Csoil max = 54,120 pCi/g)	974,909,597	491,152,365	345,079,306	167,374,095	72,816,353	2,051,331,717	**2.1E-03**
Ba-137 emitted (pCi), (95% of Cs-137)	926,164,118	466,594,747	327,825,341	159,005,390	69,175,536	1,948,765,131	**1.9E-03**
Sr-90 emitted (pCi), (Csoil max = 1,110 pCi/g proxy value of gross beta)	19,995,374	10,073,524	7,077,569	3,432,839	1,493,462	42,072,768	**4.2E-05**

[a] Input to CAP 88

Table D-10. Emission Rates from Handling Wet Sludge Materials

Pickup and dropping emissions from excavation (lb/Ton)	PM-30	PM-15	PM-10	PM-5	PM-2.5	Sums	Sum Ci
*E** = emission factor (lb emitted/Ton handled)	2.2E-06	1.4E-06	1.0E-06	5.9E-07	3.2E-07	5.5E-06	
lbs sludge and filter shake emitted (@14.4 tons)	1.8E-05	1.2E-05	8.6E-06	4.9E-06	2.7E-06	4.6E-05	
grams soil emitted (@ 14.4 tons)	8.2E-03	5.3E-03	3.9E-03	2.2E-03	1.2E-03	2.1E-02	
Co-60 emitted (pCi), (max-total from V-tanks and sand filter = 5.6 E + 5 pCi/g	4.7E+03	3.0E+03	2.2E+03	1.3E+03	6.9E+02	1.2E+04	**1.2E-08**
Cs-137 emitted (pCi), (max-total from V-tanks and sand filter = 1.3 E + 7 pCi/	1.1E+05	7.1E+04	5.2E+04	2.9E+04	1.6E+04	2.8E+05	**2.8E-07**
Ni - 63 emitted (pCi), (max-total from V-tanks and sand filter = 1.9 E + 6 pCi/g	1.6E+04	1.0E+04	7.6E+03	4.3E+03	2.4E+03	4.1E+04	**4.1E-08**
Sr - 90 emitted (pCi), (max-total from V-tanks and sand filter = 1.7E + 7 pCi/g	2.0E+05	1.3E+05	9.4E+04	5.4E+04	2.9E+04	5.0E+05	**5.0E-07**
Ba-137M (pCi), (95% of Cs-137 = 1.2 + E7)	1.0E+05	6.7E+04	4.9E+04	2.8E+04	1.5E+04	2.6E+05	**2.6E-07**
Y-90 (pCi), (100% of Sr- 90, 1.7E + 7)	2.0E+05	1.3E+05	9.4E+04	5.4E+04	2.9E+04	5.0E+05	**5.0E-07**
k = particle size multiplier EPA (1998)	0.74	0.48	0.35	0.2	0.11		
U =mean wind speed (mph) (DOE 2000b)	8.2						
M = moisture content (%), the materials will be wet (sludges)	90						
Constant	0.0032						
* E Factor = Enclosed system factor (conservative engineering judgment)	0.1						
Tons of sludge and filter shake handled	8.3						
Example estimate of *E* for PM-30 below							
See Equation D-3							
Equation modified from EPA (1998)							
Example estimate of Co-60 in the PM-30 range below							
Note: The concentrations listed above are the maximum inventory of the four tanks and the sand filter / the total mass of the tanks and sand filter. They are not the values reported in Table D-2. However, Table D-2 values were used to compute the maximum inventory for each tank and the sand filter.							
Table D-14 summarizes volumes and quantities of liquids, sludges, and the sand filter							

$$E(2.2E - 6\,\mathrm{lb/ton}) = 0.74 \times (0.0032) \frac{\left[\frac{8.2}{5}\right]^{1.3}}{\left[\frac{90}{2}\right]^{1.4}} \times 0.1$$

Example estimate of E for PM30 (See Table D-10 for comparison)

$$4.6E+3\,\mathrm{pCi} = \frac{2.2E-6\,\mathrm{lb}}{\mathrm{ton}} \times 8.3\,\mathrm{tons} \times \frac{454\,\mathrm{g}}{\mathrm{lb}} \times \frac{5.6\,E5\,\mathrm{pCi}}{\mathrm{g}}$$

Example estimate of CO-60 for PM30 (See Table D-10 for comparison)

Note small rounding discrepancy

D-3.3 VOCs from the V-Tank Liquids

During removal of the V-Tank contents, VOCs may be emitted from the handling and processing activities. The VOCs can then be dispersed via advective wind currents. The equations used to estimate emissions and the dispersion computation are presented in this section.

D-3.3.1 Emission of VOCs from the Solid and Liquid Handling Process

A simple relationship derived from Section 4.8 of AP-42 (EPA 1998) for cleaning a tank truck was used to develop an emission factor for application to the inventory of VOCs in both the liquids and sludges. The conservative derivation for pure chemical product is found within the bracketed portion in Equation (D-4).

$$\text{Fraction Vocs Released} = [\frac{0.474\ \text{lb/truck}}{220\ \text{lb cleaned/truck}}] = 0.0022 \qquad \text{(D-4)}$$

This emission factor, 0.0022, would actually overestimate the real V-Tank emissions because the equation was derived for pure or nearly pure chemicals. The VOCs in the V-Tanks are actually quite dilute. The three principal VOCs (trichloroethene, tetrachloroethene, and 1,1,1-trichloroethane) when summed could represent a maximum concentration of approximately 6.0%. Additionally, the VOCs are either in solution with the water, or they are adsorbed to the sludge material. Thus, they will not tend to volatilize as readily as the comparatively pure products used by the EPA in Section 4.8 of AP-42 (EPA 1998). Consequently, an additional factor of 6% will be used in Equation (D-4) to characterize the fraction of VOC released from the tanks and processing equipment. This modified emission fraction factor is presented below in Equation (D-5).

$$\text{FractionVocs Released} = [\frac{0.474\ \text{lb/truck}}{220\ \text{lb cleaned/truck}}] \times 0.06 = 1.3\text{E} - 4 \qquad \text{(D-5)}$$

The factor for the fraction of VOCs released is then applied to the inventory of VOCs processed and divided by the processing period to obtain an emission rate, as illustrated by Equation (D-6).

$$\text{mg/second} = 1.3\text{E} - 4 \times \frac{\text{VOC processing inventory (mg)}}{\text{VOC processing period (seconds)}} \qquad \text{(D-6)}$$

D-3.3.2 Estimation of Fence-Line VOC Concentrations

The Chi/Q relationship is commonly used to conservatively estimate steady state air concentrations at a location some distance from an emission source (EPA 1970). The Chi/Q factor, in units of sec/m^3, relates the effects of Gaussian dispersion and atmospheric stability into a single dispersion element. Equation (D-7) illustrates how the Chi/Q factor is applied to an emission rate.

$$\begin{gathered}\text{Air Concentration} = \text{Chi/Q factor} \times \text{Emission Rate} \\ \text{or in units} \\ \text{mg/m3} = \text{sec/meter3} \times \text{mg emitted/sec}\end{gathered} \qquad \text{(D-7)}$$

As discussed previously, the Chi/Q factor was derived using CAP-88; the wind data for the Pocatello, Idaho, airport; and the NE fence line distance of 12,000 m. As a result, the VOC dispersion estimates are based on the same relationships as the radionuclide dispersion estimates. The Chi/Q factor derived using CAP-88 for the NE wind vector is 6.2 E-8 sec/m^3. The VOC emissions in grams per second that were used to compute the fence line concentrations can be found in **bold** text in Table D-11.

Table D-11. Emissions and dispersion of volatile organic compounds from the V-Tank liquids and sludges.

VOC	Inventory (g)	Emissions (g)	**Emission Rate (g/sec)**	**Concentration at 12,000 m to the NE (mg/m^3)**
Trichloroethene	21,501	2.8	**1.6E-6**	**9.9E-11**
Tetrachloroethene	6,488	0.8	**4.9E-7**	**3.0E-11**
1,1,1-Trichloroethene	2,525	0.004	**2.1E-9**	**1.3E-13**
VOC Emission Factor = 1.3E-4				
Release duration = 60 days (1,728,000 seconds)				
Chi/Q (NE) in sec/m^3 = 6.2E-8				

An example of the VOC emission and fence line concentration estimate using TCE is provided below.

$$1.6\,\mathrm{E}-6\ \mathrm{g/sec\ emissions\ of\ TCE} = \frac{21{,}501\,\mathrm{g} \times 0.00013}{1{,}728{,}000\,\mathrm{sec}}$$

See Equation D-6

$$\frac{9.9\mathrm{E}-11\ \mathrm{mg}}{\mathrm{m3}} = \frac{1.6\mathrm{E}-6\mathrm{g}}{\mathrm{sec}} \times \frac{6.2\mathrm{E}-8\ \mathrm{sec}}{\mathrm{m3}} \times \frac{1000\mathrm{mg}}{\mathrm{g}}$$

See Equation D-7

Example VOC Emission and Fence Line Concentration Estimate

D-3.3.3 Estimation of Worker Exposure to VOC Concentrations

Worker exposure to VOCs arising from the V-Tanks and the processing of liquids and sludges will be assessed by estimating exposure point concentrations with a box model described by Dobbins (1979) as illustrated in Equation (D-8) and Figure D-1.

$$\mathrm{mg/m3} = \frac{\mathrm{emission\ rate\ (mg/sec)} \times \mathrm{length\ of\ wind\ path\ over\ the\ source\ area\ (m)}}{\mathrm{wind\ speed\ (m/sec)} \times \mathrm{box\ height\ (m)} \times \mathrm{source\ area\ (m2)}} \qquad \text{(D-8)}$$

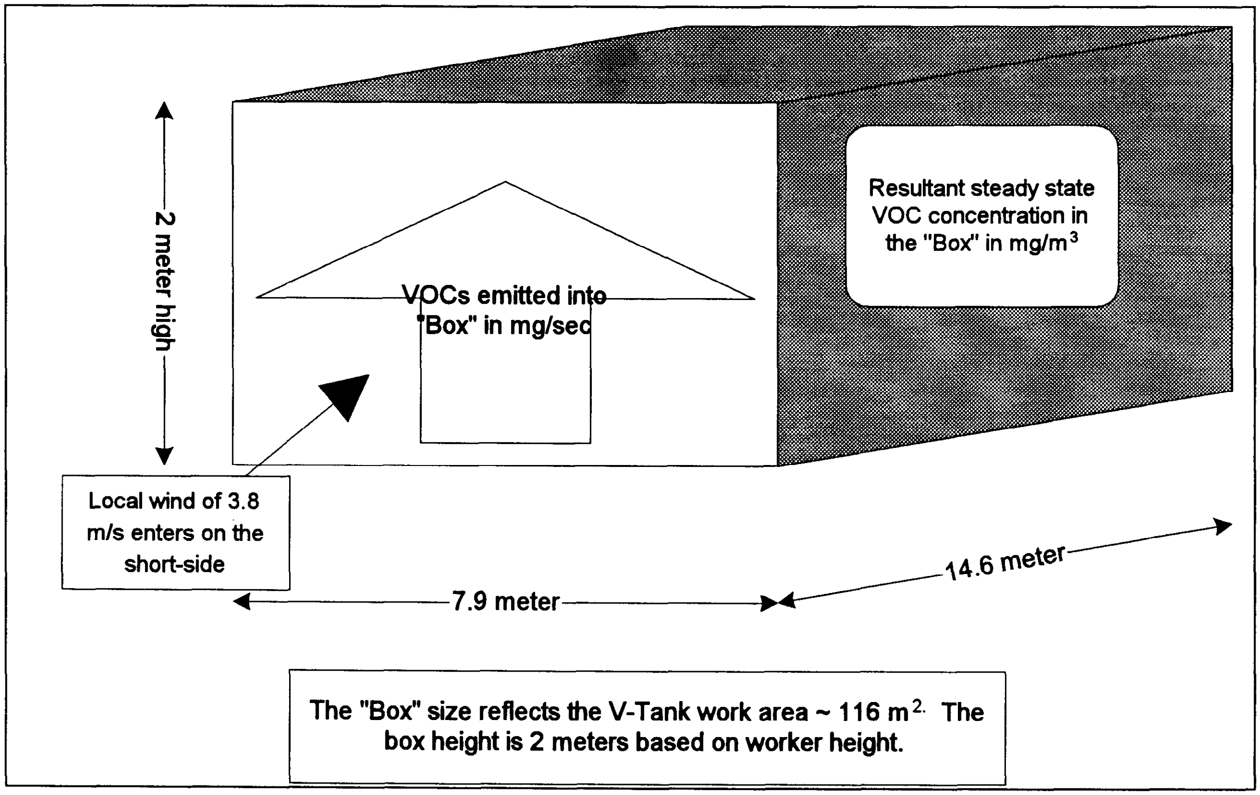

Figure D-1. Box Model for Estimating Worker Exposure Concentrations.

Worker exposure concentration estimates are provided in Table D-12.

Table D-12. Emissions and worker exposure estimates from volatile organic compounds from the V-Tank liquids and sludges.

VOC	Inventory (g)	Emissions (g)	**Emission Rate (g/sec)**	**Concentration In the Box (mg/m^3)**
Trichloroethene	21,501	2.8	**1.6E-6**	**1.5E-5**
Tetrachloroethene	6,488	0.8	**4.9E-7**	**4.5E-6**
1,1,1-Trichloroethene	2,525	0.004	**2.1E-9**	**1.9E-8**

VOC Emission Factor = 1.3E-4.

Release duration = 60 days (1,728,000 seconds).

Length of wind path over the source 7.9 meters.

Wind speed = 3.8 m/sec.

Box height = 2 m.

Area of emissions $115.3m^2$ ~$116m^2$.

(See Figure D-1).

An example of the VOC emission and worker exposure concentration estimate using TCE is provided below.

$$1.6\text{E-}6 \text{ g/sec emissions of TCE} = \frac{21{,}501\,\text{g} \times 0.00013}{1{,}728{,}000\,\text{sec}}$$

See Equation D-6

$$1.5\,\text{E-}5\,\text{mg/m3 TCE} = \frac{\frac{1.6\text{E-}6}{\text{sec}} \times 7.8\,\text{m}}{\frac{3.8\,\text{m}}{\text{sec}} \times 2\,\text{m} \times 116\,\text{m2}} \times 1000\,\text{mg/g}$$

See Equation D-8 (Note small round off difference with table value)

Example VOC Emission and Fence Line Concentration Estimate

The quantities and volumes used in the emission equations can be reviewed in Table D-13. Table D-14 contains quantities and volumes of liquids, sludges, and the sand filter. Key values are noted in **bold.**

Table D-13. Quantities and Volumes of Soils.

Source	yd^3	m^2	lb	Tons	grams
Area around Tanks and Piping	1,250	115.3	3.7E+06	1.9E+03	1.7E+09
Surrounding Controlled Area	2,200	275	6.6E+06	3.3E+03	3.0E+09
Total Controlled And EA	3,450	390	1.0E+07	5.2E+03	4.7E+09
Import Fill	500	NA	1.5E+06	7.5E+02	6.8E+08
Total All Soils Handled	**3,950**	**390**	1.2E+07	**5.9E+03**	5.4E+09

Note: 390 m^2 was used as the CAP-88 source area.

The total quantity of soil used to estimate emissions was 5,919 tons.

Soil density = 1.78 g/cc or 111 lb/ft^3.

See also Section 6 of the RD/RA WP.

D-14. Quantities and Volumes of Liquids, Sludges, and Sand Filter.

Element	Tank V-1	Tank V-2	Tank V-3	Tank V-9	Sand Filter	Total
Inventory Sludge and Liquid, gal	1.68E+03	1.60E+03	8.30E+03	3.20E+02	–	**1.19E+04**
Inventory Sludge, gal	5.20E+02	5.20E+02	6.52E+02	2.50E+02	–	1.94E+03
Inventory Liquid, gal	1.16E+03	1.08E+03	7.65E+03	7.00E+01	–	9.96E+03
Inventory Sludge, grams	**2.01E+06**	**2.01E+06**	**2.52E+06**	**9.65E+05**	–	**7.50E+06**
Inventory Liquid, grams	**4.41E+06**	**4.07E+06**	**2.89E+07**	**2.65E+05**	–	3.77E+07
Sand Filter, grams	–	–	–	–	**3.53E+04**	–
Total Sand Filter and Sludge, grams	–	–	–	–	–	**7.53E+06**
Total Sand Filter and Sludge, pounds	–	–	–	–	–	1.66E+04
Total Sand Filter and Sludge, tons	–	–	–	–	–	**8.3**
Sand Filter Contents, ft^3	**0.7**	–	–	–	–	–
Unit Conversions	–	–	–	–	–	–
Density, sludge, g/cc	1.02	–	–	–	–	–
cc/gal	3,785	–	–	–	–	–
Density, soil and sand filter shake, g/cc	1.78	–	–	–	–	–

Inventory Sludge, grams and Inventory Liquid, grams were used to estimate VOC emissions.

Total sand filter and sludge quantity of 8.3 tons (7.53E+06 grams) was used for the estimation of radionuclide emissions from the V-Tank solids.

See also Section 6 of the RD/RA WP.

D-4. REFERENCES

DOE, 1997, *CAP-88,* Version 2.0, Department of Energy, DOE-ER-8GTN-EPA, 1997.

DOE-ID, 2000a, *Comprehensive Remedial Design/Remedial Action Work Plan for the Test Area North, Operable Unit1-10, Group 1 Site,* Department of Energy Idaho Operations Office, DOE/ID-10712, Revision 0, August 2000.

DOE-ID, 2000b, *Field Sampling Plan for V-Tanks, TSF-09/18, at Waste Area Group 1 Operable Unit 1-10 Remedial Action,* Department of Energy Idaho Operations Office, DOE/ID-10794, Revision 0, November 2000.

Dobbins, R.A., 1979. *Atmospheric Motion and Air Pollution,* John Wiley & Sons, New York.

EPA, 1970, *Workbook of Atmospheric Dispersion Estimates (AP-26)*, Office of Air Programs, U.S. Environmental Protection Agency, Washington, D.C.

EPA 1998, *Compilation of Air Pollutant Emission Factors, AP-42,* Fifth Edition, Volume I: *Stationary Point and Area Sources,* Office of Air Quality Planning and Standards, January 1995 (Section 13.2.4), January 1995 (Section 4.8), and September 1998 (Section 13.2.2).

Grove Engineers, 1995, *Rad Decay*, Version 1.1.

IDAPA, 2001. Idaho Administrative Procedures Act, Requirements for Toxic Air Pollutants, Section 58.01.01, 585, and 586.

OSHA, 1997, *Regulations for General Industry*, Occupational Safety and Health Administration, 29 CFR 1910.

D-5. CAP-88 OUTPUTS

Summary CAP-88 computer outputs are presented in the following pages in this order:

- Emissions from excavation of soils in the excavation area at the V-Tanks
- Emissions from handling and transfer of sludges and filter shake at the V-Tanks
- Chi/Q derived from emissions from handling and transfer of sludges and filter shake at the V-Tanks run.

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                         C A P 8 8 - P C

                          Version 2.00

             Clean Air Act Assessment Package - 1988


                      S Y N O P S I S R E P O R T

                  Non-Radon Individual Assessment
                      Sep 26, 2001 12:02 pm

                          File VSOLFINA

           Facility: INEEL, V-Tanks Located In Test Area North
           Address: INEEL
                  Worst-Case Emissions from Soils
           City: INEEL
           State: ID Zip: 83415


           Source Category: DOE Facilities
           Source Type: Area
           Emission Year: 2001


           Comments: Emissions from Excavation of Soils in the Secured
                     Area & AOC & Fill at the V-Tanks
```

Effective Dose Equivalent
(mrem/year)

6.51E-04

At This Location: 12,000 Meters Northeast

Dataset Name: V-Tank Soils Fen
Dataset Date: Sep 26, 2001 12:02 pm
Wind File: C:\CAP88PC2\WNDFILES\PIH0359.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 12,000 Meters Northeast
Lifetime Fatal Cancer Risk: 1.34E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	3.81E-04
BREAST	3.58E-04
R MAR	1.93E-03
LUNGS	3.06E-04
THYROID	3.71E-04
ENDOST	3.93E-03
RMNDR	3.49E-04
EFFEC	6.51E-04

RADIONUCLIDE EMISSIONS DURING THE YEAR 2001

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CO-60	Y	1.00	2.3E-05	2.3E-05
CS-137	D	1.00	2.1E-03	2.1E-03
BA-137M	D	1.00	1.9E-03	1.9E-03
SR-90	D	1.00	4.2E-03	4.2E-03
Y-90	Y	1.00	4.2E-03	4.2E-03

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 89 cm/y
Mixing Height: 800 m

SOURCE INFORMATION

Source Number: 1

Source Height (m): 3.
Area (sq m): **390.**

Plume Rise
Momentum (m/s): 0.
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

12,000 16,000 20,000 22,000 25,000

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 12,000 Meters Northeast
Lifetime Fatal Cancer Risk: 6.99E-11

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	8.12E-07
BREAST	7.69E-07
R MAR	1.69E-05
LUNGS	6.98E-07
THYROID	7.93E-07
ENDOST	3.68E-05
RMNDR	1.07E-06
EFFEC	3.88E-06

RADIONUCLIDE EMISSIONS DURING THE YEAR 2001

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CO-60	Y	1.00	1.1E-08	1.1E-08
CS-137	D	1.00	3.9E-06	3.9E-06
BA-137M	D	1.00	3.7E-06	3.7E-06
SR-90	D	1.00	4.2E-05	4.2E-05
Y-90	Y	1.00	4.2E-05	4.2E-05

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 89 cm/y
Mixing Height: 800 m

SOURCE INFORMATION

Source Number:	1
Source Height (m):	3.
Area (sq m):	390.
Plume Rise Momentum (m/s): (Exit Velocity)	0.

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

12,000 16,000 20,000 22,000 25,000

C A P 8 8 - P C

Version 2.00

Clean Air Act Assessment Package - 1988

File Vslgfina

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Sep 27, 2001 04:22 am

Facility: INEEL, V-Tanks Located In Test Area North
Address: INEEL
Worst-Case Emissions Sludges
City: INEEL
State: ID Zip: 83415

Source Category: DOE Facilities
Source Type: Area
Emission Year: 2001

Comments: Emissions from Handling and Transfer of Sludges
Filter Shake at the V-Tanks

Effective Dose Equivalent
(mrem/year)

8.34E-08

At This Location: 12,000 Meters Northeast

Dataset Name: Vsludges Final
Dataset Date: Sep 27, 2001 04:22 am
Wind File: C:\CAP88PC2\WNDFILES\PIH0359.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 12,000 Meters Northeast
Lifetime Fatal Cancer Risk: 1.73E-12

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	5.12E-08
BREAST	4.81E-08
R MAR	2.38E-07
LUNGS	4.13E-08
THYROID	4.99E-08
ENDOST	4.81E-07
RMNDR	4.65E-08
EFFEC	8.34E-08

RADIONUCLIDE EMISSIONS DURING THE YEAR 2001

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CO-60	**Y**	**1.00**	**1.2E-08**	**1.2E-08**
CS-137	**D**	**1.00**	**2.8E-07**	**2.8E-07**
BA-137M	**D**	**1.00**	**2.6E-07**	**2.6E-07**
SR-90	**D**	**1.00**	**5.0E-07**	**5.0E-07**
NI-63	**W**	**1.00**	**4.1E-08**	**4.1E-08**
Y-90	**Y**	**1.00**	**5.0E-07**	**5.0E-07**

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 89 cm/y
Mixing Height: 800 m

SOURCE INFORMATION

Source Number:	1
Source Height (m):	0.
Area (sq m):	**116.**
Plume Rise Momentum (m/s): (Exit Velocity)	0.

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

12,000 16,000

C H I / Q T A B L E S

Non-Radon Individual Assessment
Sep 25, 2001 03:39 pm

File Vslgfina

Facility: INEEL, V-Tanks Located In Test Area North
Address: INEEL
Worst-Case Emissions Sludge
City: INEEL
State: ID Zip: 83415

Source Category: DOE Facilities
Source Type: Area
Emission Year: 2001

Comments: Emissions from Handling and Transfer of Sludges
Filter Shake at the V-Tanks

Dataset Name: Vsludges Final
Dataset Date: Sep 25, 2001 03:39 pm
Wind File: C:\CAP88PC2\WNDFILES\PIH0359.WND

GROUND-LEVEL CHI/Q VALUES FOR CO-60
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)		
Dir	12,000	16,000	
N	4.479E-08	3.011E-08	
NNW	1.592E-08	1.067E-08	
NW	1.697E-08	1.138E-08	
WNW	1.189E-08	7.928E-09	
W	2.500E-08	1.683E-08	
WSW	1.933E-08	1.299E-08	
SW	3.861E-08	2.580E-08	
SSW	2.758E-08	1.840E-08	
S	2.889E-08	1.941E-08	
SSE	1.362E-08	9.176E-09	
SE	1.707E-08	1.147E-08	
ESE	8.675E-09	5.786E-09	
E	2.022E-08	1.341E-08	
ENE	3.261E-08	2.153E-08	
NE	**6.156E-08**	4.109E-08	**Chi/Q for VOC Estimation**
NNE	5.678E-08	3.836E-08	

GROUND-LEVEL CHI/Q VALUES FOR CS-137
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)	
Dir	12,000	16,000
N	4.479E-08	3.011E-08
NNW	1.592E-08	1.067E-08
NW	1.697E-08	1.138E-08
WNW	1.189E-08	7.928E-09
W	2.500E-08	1.683E-08
WSW	1.933E-08	1.299E-08
SW	3.861E-08	2.580E-08
SSW	2.758E-08	1.840E-08
S	2.889E-08	1.941E-08
SSE	1.362E-08	9.176E-09
SE	1.707E-08	1.147E-08
ESE	8.675E-09	5.786E-09
E	2.022E-08	1.341E-08
ENE	3.261E-08	2.153E-08
NE	6.156E-08	4.109E-08
NNE	5.678E-08	3.836E-08

GROUND-LEVEL CHI/Q VALUES FOR BA-137M
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)	
Dir	12,000	16,000
N	9.280E-12	5.183E-13
NNW	2.859E-12	1.598E-13
NW	3.061E-13	9.753E-15
WNW	1.835E-13	5.874E-15
W	3.500E-13	1.134E-14
WSW	3.014E-13	9.596E-15
SW	7.665E-13	2.397E-14
SSW	6.212E-13	1.919E-14
S	4.571E-13	1.468E-14
SSE	2.137E-13	6.874E-15
SE	3.049E-13	9.673E-15
ESE	4.736E-13	1.604E-14
E	5.271E-12	2.936E-13
ENE	1.818E-11	1.195E-12
NE	8.527E-12	3.759E-13
NNE	2.606E-12	8.546E-14

GROUND-LEVEL CHI/Q VALUES FOR SR-90
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)	
Dir	12,000	16,000
N	4.479E-08	3.011E-08
NNW	1.592E-08	1.067E-08
NW	1.697E-08	1.138E-08
WNW	1.189E-08	7.928E-09
W	2.500E-08	1.683E-08
WSW	1.933E-08	1.299E-08
SW	3.861E-08	2.580E-08
SSW	2.758E-08	1.840E-08
S	2.889E-08	1.941E-08
SSE	1.362E-08	9.176E-09
SE	1.707E-08	1.147E-08
ESE	8.675E-09	5.786E-09
E	2.022E-08	1.341E-08
ENE	3.261E-08	2.153E-08
NE	6.156E-08	4.109E-08
NNE	5.678E-08	3.836E-08

GROUND-LEVEL CHI/Q VALUES FOR NI-63
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)	
Dir	12,000	16,000
N	4.479E-08	3.011E-08
NNW	1.592E-08	1.067E-08
NW	1.697E-08	1.138E-08
WNW	1.189E-08	7.928E-09
W	2.500E-08	1.683E-08
WSW	1.933E-08	1.299E-08
SW	3.861E-08	2.580E-08
SSW	2.758E-08	1.840E-08
S	2.889E-08	1.941E-08
SSE	1.362E-08	9.176E-09
SE	1.707E-08	1.147E-08
ESE	8.675E-09	5.786E-09
E	2.022E-08	1.341E-08
ENE	3.261E-08	2.153E-08
NE	6.156E-08	4.109E-08
NNE	5.678E-08	3.836E-08

GROUND-LEVEL CHI/Q VALUES FOR Y-90
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)	
Dir	12,000	16,000
N	4.403E-08	2.943E-08
NNW	1.560E-08	1.038E-08
NW	1.654E-08	1.100E-08
WNW	1.158E-08	7.652E-09
W	2.443E-08	1.631E-08
WSW	1.892E-08	1.263E-08
SW	3.778E-08	2.507E-08
SSW	2.698E-08	1.787E-08
S	2.827E-08	1.885E-08
SSE	1.333E-08	8.917E-09
SE	1.668E-08	1.112E-08
ESE	8.500E-09	5.630E-09
E	1.986E-08	1.309E-08
ENE	3.216E-08	2.113E-08
NE	6.063E-08	4.026E-08
NNE	5.590E-08	3.757E-08

GROUND-LEVEL CHI/Q VALUES FOR ZN-65
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

	Distance (meters)		
Dir	12,000	16,000	
N	4.479E-08	3.011E-08	
NNW	1.592E-08	1.067E-08	
NW	1.697E-08	1.138E-08	
WNW	1.189E-08	7.928E-09	
W	2.500E-08	1.683E-08	
WSW	1.933E-08	1.299E-08	
SW	3.861E-08	2.580E-08	
SSW	2.758E-08	1.840E-08	
S	2.889E-08	1.941E-08	
SSE	1.362E-08	9.176E-09	
SE	1.707E-08	1.147E-08	
ESE	8.675E-09	5.786E-09	
E	2.022E-08	1.341E-08	
ENE	3.261E-08	2.153E-08	
NE	**6.156E-08**	4.109E-08	CHI/Q for VOC estimates
NNE	5.678E-08	3.836E-08	